Constructing high-frequency monetary policy surprises from SOFR futures

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Eurodollar futures were the bedrock for constructing high-frequency series of monetary policy surprises, so their discontinuation poses a challenge for the continued empirical study of monetary policy. We propose an approach for updating the series of Gürkaynak et al. (2005) and Nakamura and Steinsson (2018) with SOFR futures in place of Eurodollar futures that is conceptually and materially consistent. We recommend using SOFR futures from January 2022 onward based on regulatory developments and trading volumes. The updated series suggest that surprises over the recent tightening cycle are larger in magnitude than those seen over the decade prior and restrictive on average.

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Understanding the effects of monetary policy on economic and financial outcomes is a longstanding objective of monetary economics. Identifying the causal effects of monetary policy hinges on isolating changes in policy that are exogenous—that is, attributed to monetary policy actions or communications beyond the endogenous response to economic outcomes. Gürkaynak et al. (2005) and Nakamura and Steinsson (2018) (henceforth, GSS and NS, respectively) designed series of monetary policy surprises that capture exogenous variation in the current and, crucially, the future path of policy—a central feature of modern monetary policy. These series rely on changes in market prices of Eurodollar futures contracts in short time windows around FOMC announcements. However, with the phaseout of LIBOR, Eurodollar futures no longer exist, making it impossible to directly update these series of monetary policy surprises.[1]

The contribution of this paper is to document how these workhorse series of monetary policy surprises can continue to be updated using Secured Overnight Financing Rate (SOFR) futures as an alternative for Eurodollar futures. We describe institutional features of Eurodollar and SOFR futures and show that between mid-2018 and mid-2023—the time period where both were traded—intraday changes around FOMC announcements are nearly perfectly correlated. In practice, we recommend using SOFR futures starting in January 2022 due to the regulatory phase out of LIBOR at the end of 2021 and adequate trading volumes needed to reliably calculate changes in tight time windows around FOMC announcements.

Using our methodology, we update the GSS and NS series of monetary policy surprises to the present. Over the recent monetary tightening cycle, we find that surprises are larger in magnitude than those seen over the prior decade. Since March 2022, surprises are restrictive, on net, with a couple of meaningful pivots. While other papers have paired Eurodollar and SOFR futures to study the effects of monetary policy—e.g., Kroner (2024) and Boehm and Kroner (2023)—we are the first to document how to construct and update canonical series of monetary policy surprises and discuss the associated practical and institutional issues.

1 Eurodollar Futures and monetary policy surprises

Nearly all high-frequency series of monetary policy surprises rely on changes in expected interest rates at different horizons around central bank policy announcements. The changes in these expected paths of interest rates can be measured via the variation in prices of interest rate futures in a narrow window around each announcement. More specifically, the GSS and NS series span roughly the first year of the interest-rate term structure via a linear combination of federal funds futures and Eurodollar futures. The market for federal funds futures is liquid enough to measure expectations of rates roughly three months in the future. Eurodollar futures provide an instrument for measuring expectations beyond three months.

Figure 1 contains a schematic overview of quarterly Eurodollar and SOFR futures contracts that provide exposure to the interest rate term structure at an arbitrary time t. A Eurodollar futures contract expiring in quarter q was an agreement to exchange $100 - r_\tau$, where τ represents that contract's expiration day and r_τ the three-month LIBOR prevailing at day τ. Because the price of Eurodollar futures was based on a three-month term rate,

[1] "LIBOR" is an abbreviation for the U.S. dollar British Banker's Association London Interbank Overnight Rate.

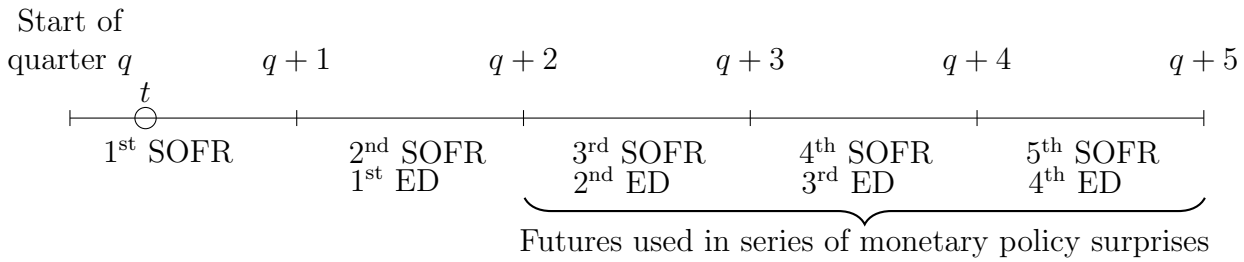

Figure 1: Interest rate exposure of Eurodollar (ED) and SOFR futures.

they incorporated market participants' expectations of the future path of interest rates in the three months *after* settlement. For example, in Figure 1, a market participant trading on date t and seeking interest rate exposure in quarter $q+1$, would have traded the first-outstanding Eurodollar future, with settlement towards the end of q.

Eurodollar futures were listed quarterly on the Chicago Mercantile Exchange (CME) from 1981 to April 2023 and were one of the most actively traded futures in the world until early 2022. Despite their widespread use, trading volume declined over the past decade, as shown in Figure 2. This can be attributed, in part, to the declining use of LIBOR leading up to its termination in June 2023. Although LIBOR was used in hundreds of trillions of dollars of financial instruments at its height of popularity, scandals in 2012 decelerated its usage as a reference rate.

2 Using SOFR Futures

In 2014, the Federal Reserve convened private sector participants to recommend a new reference rate in place of LIBOR. SOFR was endorsed in June 2017 and first released in April 2018.[2] A month later, SOFR futures began trading on the CME. In 2021, the CME announced that by April 14, 2023 all Eurodollar futures would be automatically converted to SOFR futures at a fixed spread.[3] As shown in Figure 2, declining trading volume of Eurodollar futures coincides with increasing trading volumes of SOFR futures, especially after the announcement in 2021.

SOFR futures are structured differently than Eurodollar futures. The settlement price of the quarter-q SOFR future at day τ is 100-$\mathcal{R}_q$, where $\mathcal{R}_q$ is compounded daily SOFR r_τ over the three months *preceding* the settlement date:

$$\mathcal{R}_q = \frac{100 \times 360}{D^q} \left[\prod_{d=1}^{D_b^q} \left\{ 1 + \left(\frac{\delta_{\tau-d}}{360} \right) \left(\frac{r_{\tau-d}}{100} \right) \right\} - 1 \right], \tag{1}$$

where D^q is the number of calendar days in q, D_b^q is the number of US government securities

[2]See the overview (https://www.newyorkfed.org/markets/reference-rates/sofr), and related work by Heitfield and Park (2019).

[3]The 26.161 basis point spread is based on the historical differences between LIBOR and SOFR due to the former being unsecured and the latter secured (https://www.isda.org/a/BcJgE/Progress-on-Global-Transition-to-RFRs-in-Derivatives-Markets.pdf).

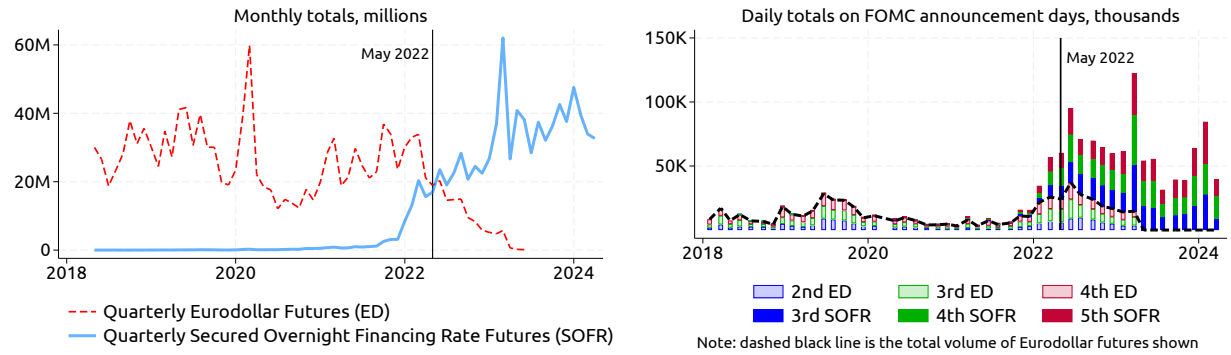

Figure 2: Trading volumes of futures used in the GSS and NS series

market business days in q, d indexes business days, r_τ SOFR, and δ_τ the number of calendar days to which r_τ applies.

Care must be taken to properly align SOFR and Eurodollar futures contracts. While Eurodollar futures were based on expected interest rates over three months *after* the settlement date, SOFR futures are based on interest rates over the three months *before*. As Figure 1 shows, both the first-outstanding Eurodollar future and the second-outstanding SOFR future are called the $q+1$ contract. Because the CME named both Eurodollar and SOFR futures based on the quarter of their interest rate exposure, they can be matched based on their contract names. Alternatively, one can match the n^{th}-outstanding SOFR contract with the $(n-1)^{\text{st}}$-outstanding Eurodollar contract.

3 Series Construction

We now turn to updating the GSS and NS series of monetary policy surprises beyond the 2023 termination of Eurodollar futures. We use CME Datamine data to construct both series using the original 30-minute changes in the prices of federal funds futures and either Eurodollar or SOFR futures around FOMC announcements. The federal funds futures contracts used for a given announcement have typically been those expiring at the end of the month of that announcement and the subsequent scheduled announcement, while the Eurodollar futures have been the second-, third-, and fourth-outstanding contracts, as shown in Figure 1. Brennan et al. (2024) provide details on federal funds futures and the selection of exact trades for both types of futures.

We ensure conceptual similarity between our updated series and the originals by replacing Eurodollar contracts with SOFR contracts that measure interest rate expectations for the same horizons. Based on the discussion in Section 2, we use the third-, fourth-, and fifth-outstanding SOFR contracts in place of the second-, third-, and fourth-outstanding Eurodollar contracts. As long as researchers use SOFR futures with horizons longer than the first-outstanding contract—as is the case in both the GSS and NS series—then differences in prices around announcements can be used without additional adjustments. Using the first-outstanding SOFR contract would require researchers to account for the pre-determination

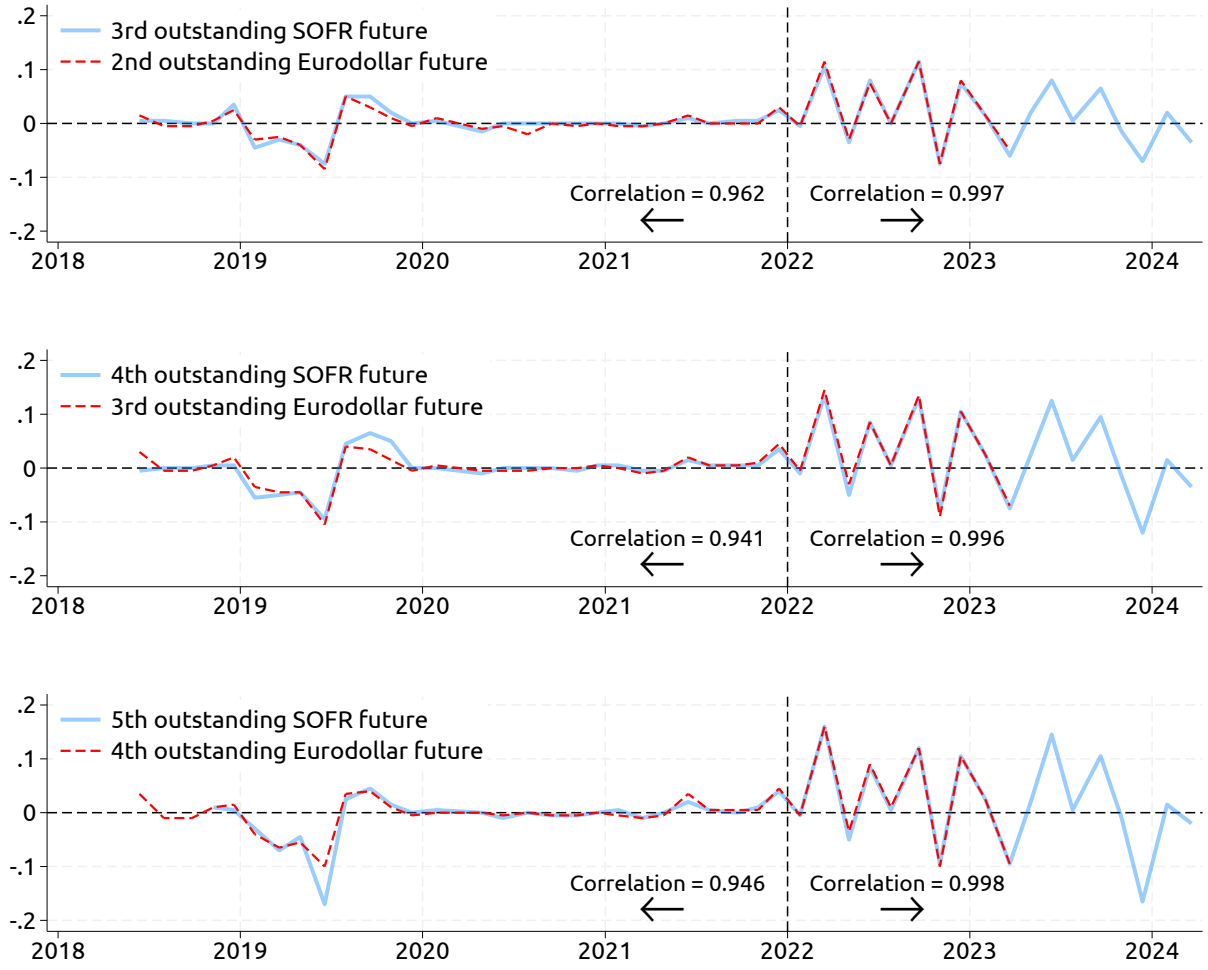

Figure 3: 30-minute changes around FOMC announcements, percentage points

of some daily SOFR r_τ used to calculate the settlement rate $\mathcal{R}_q$ in equation (1).[4] Alternative series of monetary policy surprises relying on the first-outstanding Eurodollar contract—e.g., those of Bauer and Swanson (2023)—can be updated using the second-outstanding SOFR contracts without any concerns about pre-determination.

Given that Eurodollar and SOFR futures are designed to provide nearly the same interest rate exposure, we simply append the SOFR-contract series to the Eurodollar-contract series after a certain date. Choosing which date is not obvious, since intraday changes in Eurodollar futures and SOFR futures were not identical in the years immediately following SOFR's launch, as shown in the 30-minute changes around FOMC announcements plotted in Figure 3.

We recommend switching to SOFR futures in January 2022. Ideally, one would switch in July 2021 when the Market Risk Advisory Committee encouraged market participants to transact in SOFR derivatives to avoid the risks of declining liquidity for LIBOR instruments

[4](https://www.cmegroup.com/education/articles-and-reports/three-month-sofr-futures-rates-and-future-sofr-levels.html).

like Eurodollar futures. After all, regulations aimed for US banks to cease entering new LIBOR-based contracts by late 2021.[5] Despite these regulatory developments, Figure 2 shows that although trading activity in SOFR futures was rising, it still remained quite low until 2022. January 2022 is therefore a date that assures sufficient trading volume in SOFR futures.[6] Figure 3 shows that, over the sample between our chosen switch date and the end of Eurodollar futures trading, intraday changes in SOFR and Eurodollar futures around FOMC announcements are nearly perfectly correlated.

With replacements for Eurodollar futures in hand, we present the updated NS and GSS series of monetary policy surprises in Figure 4. Through 2021, the updated and original series are nearly identical, despite the longer sample used for estimating the loadings of these factors on the underlying assets. FOMC announcements since the end of Eurodollar futures—which includes the most-recent tightening cycle—have induced restrictive surprises to the path of interest rates on net. For example, the sum of the NS series since the cycle started in March 2022 is about 20 basis points. Two meaningful pivots are large negative surprises: the first in November 2022 when markets interpreted FOMC communications as signaling a forthcoming slowdown in the pace of rate increases and the second in December 2023 when markets viewed the tightening cycle as drawing to a close.[7]

4 Conclusion

Estimating the effects of monetary policy on economic and financial outcomes is a cornerstone of research in monetary economics. The contribution of this paper is to document how workhorse series of monetary policy surprises can be updated after the discontinuation of underlying futures data. We find that intraday changes in SOFR futures can be substituted for Eurodollar futures with little material effect on the series of monetary policy surprises. We recommend substituting SOFR futures for Eurodollar futures starting in January 2022 due to regulatory developments in 2021 and ample trading activity.

[5](https://www.newyorkfed.org/arrc/sofr-transition).

[6]We also tried alternative switch dates, and a state-space model approach. Ultimately, all series were highly correlated, so we opted for the approach based on institutional knowledge.

[7]See media coverage: (https://www.bloomberg.com/news/live-blog/2023-12-13/fomc-rate-decision-and-fed-chair-news-conference) and (https://www.reuters.com/markets/us/fed-set-another-big-rate-hike-may-tamp-down-future-tightening-2022-11-02).

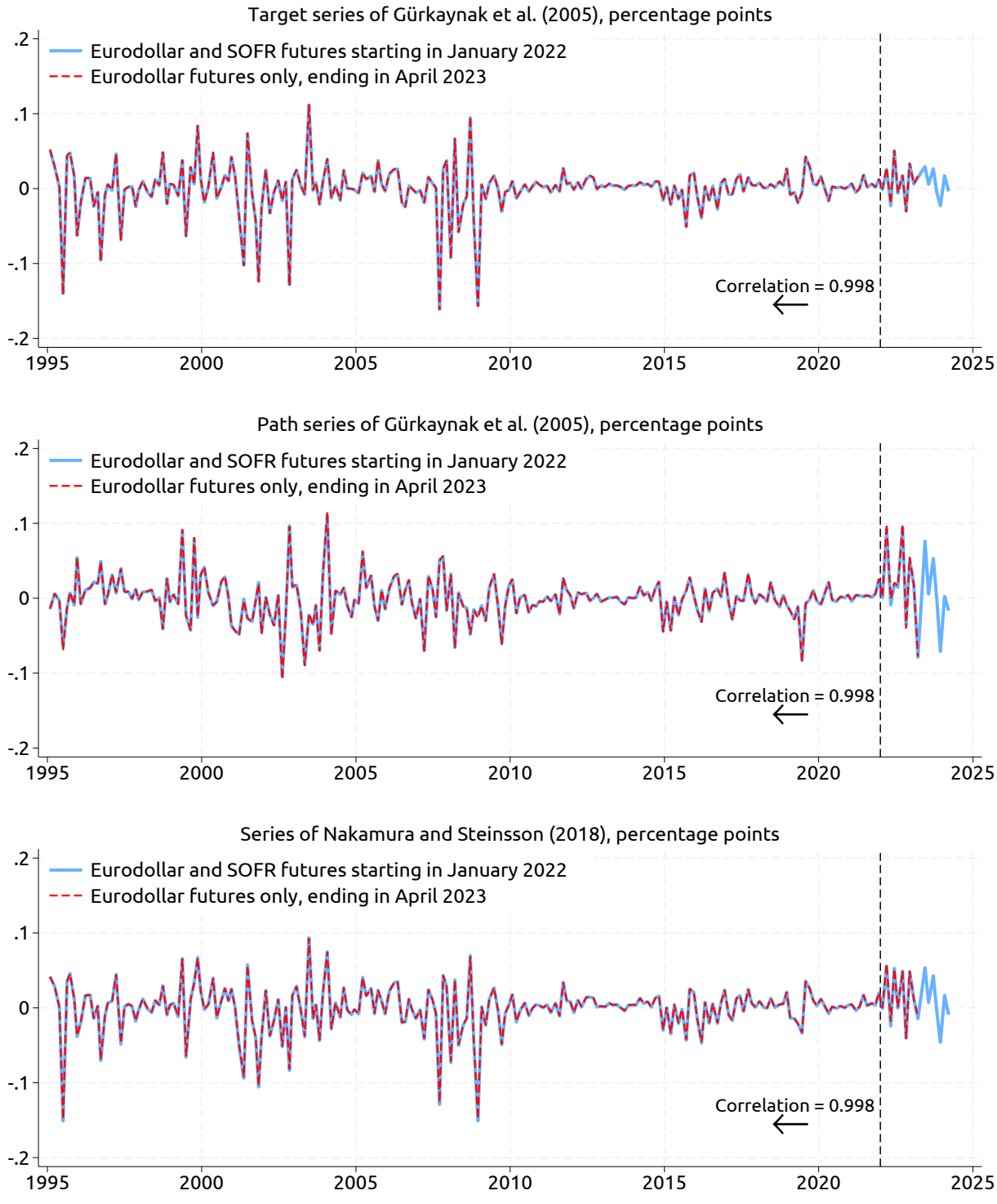

Figure 4: Series of monetary policy surprises

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